

Operational and Financial Advantages of a New Technology for Fly Ash Separation

B.Eiderman, M. Voskoboinik , H. Levy, M.Soskine.

SorTech Separation Technologies Ltd.

www.Sor-Tech.com

POB 45125, Jerusalem 91450, Israel

Abstract. Separation of dry powders often encounters technical difficulties in conventional methods, mainly for particle size smaller than 38μ . The principles underlying a newly developed machine, TriboSeparator, involve surface interactions in relative motion of dry particles in centrifugal field. Different forces are applied on the particles, among them centrifugal, inertia, gravitation and friction. These forces affect differently particles of different size and shape, resulting in separation. Experiments made on a semi-industrial model provide positive results for fly ash powders. The system's compact size, absence of medium material and low wear result in competitive investment at start-up and low operational costs.

1. Introduction

The process of Dry TriboSeparation, developed by SorTech Separation Technologies Ltd., Israel, is based on interaction of dry powder particles surfaces and inner surface of rotating around vertical axis conical bowl. Difference in friction coefficients of particles of different size, shape and material lead to their separation by joint action of the centrifugal, frictional and gravitational forces. In order to test the technological properties of the TriboSeparator, several machines were constructed. The device is designed to separate dry powders to two fractions, while separation criteria can be varied in wide range. Material is fed on the inner surface of the rotating bowl from a dosing feeder mounted above the bowl, below a bunker. After separation, fractions of the powder are retained in separate collectors. As our experiments demonstrate, the dry TriboSeparator is most effective in the following cases:

- a) Separation by shape between spherical and non spherical particles of various size, including the case of separation between differently shaped particles having the same size, say cylinder and sphere having the same radius.
- b) Separation by size
- c) Removing dust from dust material or scalping.

2. Theoretical Basics of Dry TriboSeparation

The movement of a particle near any point on the rotating inner surface may be considered as a movement on a correspondent tangent plane.

Let us take it that

$$\frac{dX}{dY} = \frac{V_x}{V_y} \quad (1)$$

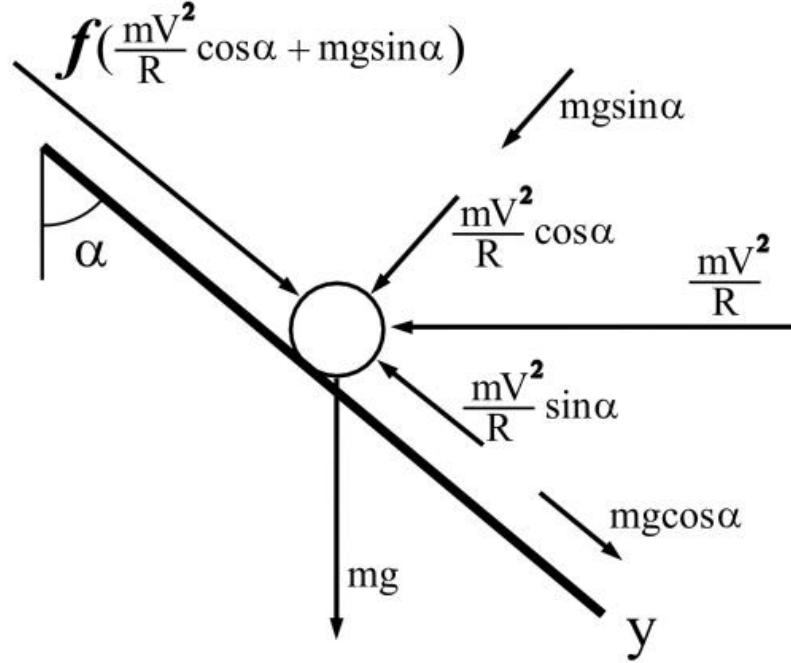


Figure 1: Diagram of Forces

The movement trajectory of a particle on the inner surface is defined by equation (1), where V_x and V_y are velocities of particle movement in longitudinal and cross directions.

$$\frac{dY}{dX} = \tan \mathbf{q},$$

where \mathbf{q} – angle of elevation of a particle trajectory. The velocities V_x and V_y can be defined by equation of particle movement on rotating inner surface and may be presented as:

$$\begin{aligned} V_x &= V(f, \mathbf{a}, R_x, n, \mathbf{j}, V_{0x}) \\ V_y &= V(f, \mathbf{a}, R_{1y}, R_{2y}, n, V_{0y}). \end{aligned} \quad (2)$$

Where: f – friction coefficient of a particle friction towards inner surface, \mathbf{a} – inclination angle of the inner surface, R_x – radius of the surface in longitudinal

direction, n - revolution per minute of the inner surface, \mathbf{j} – the angle of a particle movement in longitudinal direction, V_{0x} – initial particle velocity in longitudinal direction, R_{1y} and R_{2y} – initial and final radius of the surface. V_{0y} – initial particle velocity in cross direction. (Fig.1)

Powder is fed to a certain zone which is designated a feeding zone and which is positioned adjacement to a lower portion of the inner surface. The length of this zone is designed to be much less (at least by an order of magnitude) than the length of the separation zone, with the length of the separation zone being approximately l_s . The length of the separation zone is determined by the relationship:

$$l_s = l_y * V / V_y, \quad (3)$$

where l_y is the distance between the lower edge of the feeding zone to the upper edge of the inner surface along the generatrix of the surface of revolution; V is the linear velocity of the upper edge of inner surface.

3. Experimental Results

Samples of Fly Ash were separated on the semi-industrial model of SorTech's TriboSeparator. Initial material was partitioned into two fractions, Fine Fraction and Coarse Fraction. Study of bowl rotation speed was fulfilled for particle size distribution and carbon content in both fractions:

Table 1: Fly Ash Separation Results

V, Hz	Coarse fraction			Fine fraction		
	Carbon, %	Mean D, μ	Output, %	Carbon, %	Mean D, μ	Output, %
12	12.4	116	11	4.3	35	89
14	11.4	112	22	3.9	30	78
16	8.4	113	29	3.7	27	71
18	7.9	83	37	2.5	25	63
22	6.2	63	51	2.3	19	49
25	6.7	64	59	2.8	19	41
30	5.9	68	66	1.1	18	34

95% of the fly ash sample particles reported here were of diameter less than 147μ . The carbon percentage was 5.7% (measurement resolution 0.5%). Tests were made in collaboration with the Israeli Electric Company's coal power plant M.D.1.

When bowl rotation speed increased up to 2.5 times from base speed:

- median diameter of fine fraction particles varied from 35μ to 18μ ;
- median diameter of coarse fraction particles varied from 116μ to 68μ .

Carbon percentage decreased in the fine fraction from 4.3% to 1.1% and in the coarse fraction from 12.4% to 5.9%. Particles size distribution is presented in Figures 2A-2C.

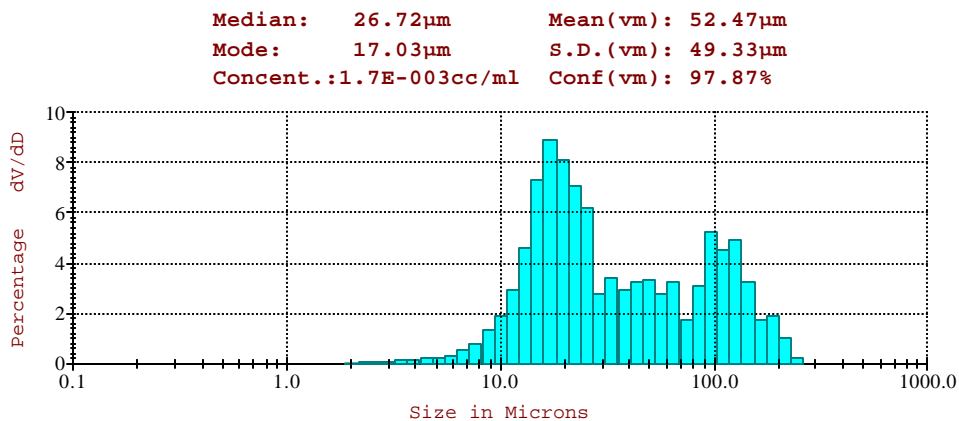


Figure 2A: Fly Ash Particles Size Distribution: Feed Material

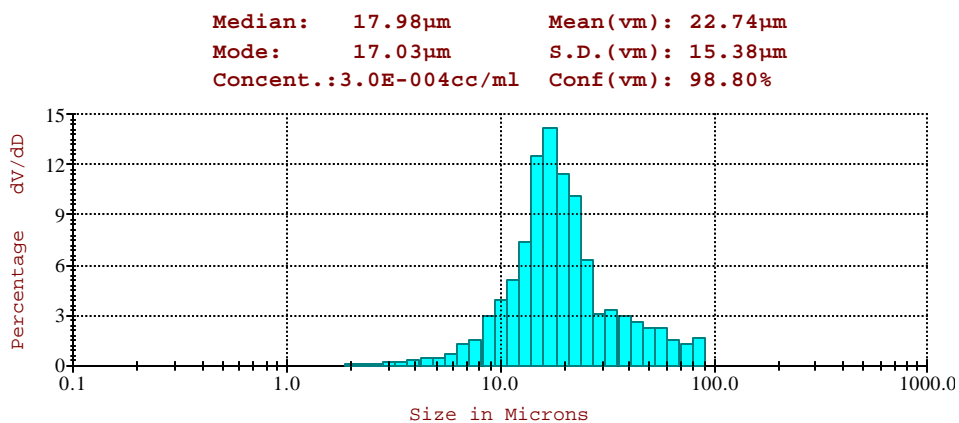


Figure 2B: Fly Ash Particles Size Distribution: Fine Fraction

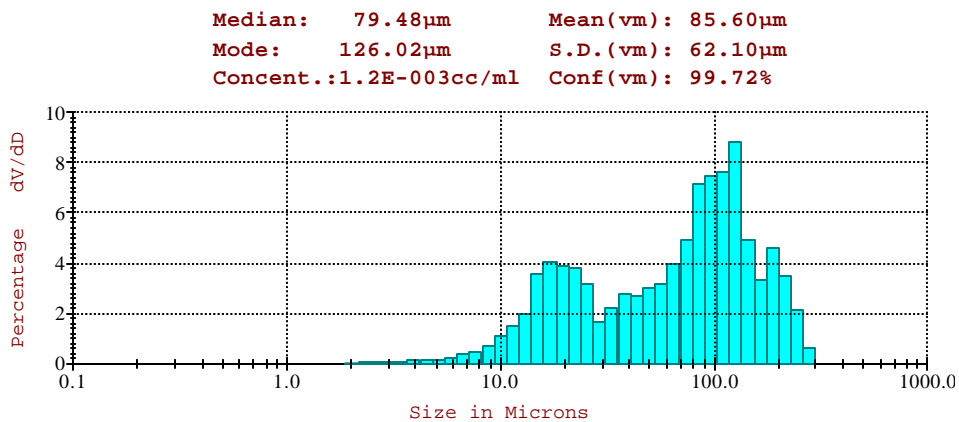


Figure 2C: Fly Ash Particles Size Distribution: Coarse Fraction

4. Conclusion

The operational and financial advantages of the TriboSeparator when applied for Fly Ash may be summarized as follows:

The fine fraction may be designed to contain a rate of unburned carbon in the range of 1.1%-4.3%, thus highly valued by concrete manufacturers; variability of unburned carbon in the fine fraction ranges ± 0.4 percentage points depending on feed material, which is most valuable for concrete producers; it mainly contains small particles (95% less than 58 μ).

Depending on feed, the Fly Ash Coarse fraction typically contains more than 6% carbon, thus increase availability of the alternative Carbon-Burn-Out (CBO) technology. Moreover, CBO will gain efficiency by handling the coarse fraction only (some 30-50% of the feed material, depending on desired carbon concentration). Alternatively, the coarse fraction could be milled and returned to separation and/or combustion. Using this technology, unburned carbon may be extracted for commercial uses other than burn-out, thus add significant value. The TriboSeparation process has no negative ecological side-effects, it consumes little electrical power and no medium material.

5. References.

1. B.Eiderman. Triboseparator for dry particles and powders. Proceedings of the 14th conference of the Israel mineral science and engineering association. PpE17-E19, 1998.
2. B.Eiderman et all. Centrifugal Separator for Dry Components. US Registered Patent (Number not yet assigned). Filing Date: June, 1997.